

## 2.0 INTRODUCTION

The Surface Water Ambient Monitoring Program (SWAMP) for the San Joaquin River (SJR) Basin is built upon a monitoring framework developed as part of the agricultural subsurface drainage management program that focuses on selenium, salt and boron and has evolved since 1985. The current SWAMP program contains 3 tiers. The first layer is a selection of sites along the main stem of the river, downstream of major inflows. The second layer is a series of sites representing inflows from specific sub-watersheds into the main stem of the river (drainage basin inflows component). The final layer, the Intensive Basin Monitoring Program (IBP), is a more detailed, yearlong survey of the water quality within each of the sub-watersheds once every 5-years.

To accomplish the monitoring objectives for the IBP, the SJR Watershed was divided into five basins. Each of these basins included water bodies with similar hydrologies, geologies, management issues, land use and land cover. A sixth basin was identified, the Sacramento – San Joaquin Delta. The Delta has not been included as part of the rotation due to the extensive monitoring and modeling already conducted by other agencies.

Once every five years, funding permitting, expanded monitoring "rotates" into one of the sub-basins. The purpose of each rotation is to identify current monitoring efforts within the sub-basin (agency and local) as well as any local water quality concerns, evaluate spatial and temporal trends of key constituents, and determine whether there is any evidence that beneficial uses are not being protected. Resulting information will be incorporated into the biannual statewide 305b assessment report.

During the rotation, sampling sites are selected based on land use in sub areas, coordination with other monitoring efforts, and local stakeholder input, and then monitored twice a month for 1-year. Constituent selection is based on: historic information; data gathered as part of the drainage basin inflows component; stakeholder response to a monitoring survey; and available funding. At a minimum, each site is analyzed for standard field measurements (EC, pH, temperature, turbidity, and DO) as well as total Coliform and *E. coli*. Monthly photo documentation was taken at each site.

This study focuses on the Northeast Basin, consisting of the Cosumnes, Mokelumne, and Calaveras River Watersheds. Prior to initial water quality sampling, 58 state, federal, and local agencies as well as know watershed groups were surveyed to identify current monitoring efforts and local concerns (Appendix E). Monitoring during the time of the study was limited to selected gages maintained by the California Department of Water Resources and US Geological Survey, and targeted studies conducted by the University of California and others. Data for the targeted studies was not readily accessible. Local concerns were focused on potential impacts to aquatic life and recreation in the upper watershed, in particular concerns with temperature, sedimentation, and pathogens, with additional concerns of irrigation supply (elevated salt) and drinking water (elevated total organic carbon) in the lower watershed. The final sampling design incorporated the initial survey findings.

Available funding allowed for monitoring twice a month for measurements identified above, between January – December 2002. Additional funding allowed limited total organic carbon, total suspended solids, toxicity, nutrients, and trace element monitoring at selected sites during part of the study period. The combination of parameters allowed for development of initial baseline data as well as a preliminary assessment of potential impacts to the following beneficial uses:

Drinking Water	(Salt/Electrical Conductivity, Total Organic Carbon, Trace Elements, <i>E. coli</i> , Nutrients)
Aquatic Life	(Toxicity, Temperature, Dissolved Oxygen, Trace Elements, Ammonia, pH)
Recreation	( <i>E. coli</i> )
Irrigation Supply	(Salt/Electrical Conductivity)

Details for overall SWAMP monitoring objectives and indicators, as well as for basins not included in this study can be found on the Central Valley Regional Water Quality Control Board SWAMP website at: [www.waterboards.ca.gov/centralvalley/programs/agunit/swamp/index.html](http://www.waterboards.ca.gov/centralvalley/programs/agunit/swamp/index.html).

### 3.0 STUDY AREA

This report is on water quality in the Northeast Basin, one of 5 sub-basins draining into the San Joaquin River. More details on the overall hydrology of the SJR Basin and details of the Northeast Basin follow.

#### 3.1 San Joaquin River Hydrology

The San Joaquin River (SJR) is the principal drainage artery of the San Joaquin Valley. The basin covers 17,720 square miles (Basin Plan, 2002) and yields an average annual surface runoff of about 1.6 million acre-feet. The SJR basin drains the portion of the Central Valley south of the Sacramento-San Joaquin Delta and north of the Tulare Lake Basin.

The river flows westward from the Sierra Nevada and turns sharply north at Mendota Pool near the town of Mendota. Most of the SJR flow is diverted into the Friant-Kern Canal, leaving the river channel upstream of the Mendota Pool dry except during periods of wet weather flow and major snow melt. The river continues past Mendota Pool to form a broad flood plain, as it turns northward, for a distance of approximately 50 miles until the river is narrowed by the constrictions of the Merced River and Orestimba Creek alluvial fans.

Flows from the east side of the river basin to the San Joaquin River are dominated by flow from the Merced, Tuolumne, and Stanislaus Rivers, which primarily carry snowmelt from the Sierra Nevada. Flows from the west side of the river basin are dominated by agricultural return flows since west side streams are ephemeral and their downstream channels are used to transport agricultural return flows to the main river channel. Poorer quality (higher salinity) water is imported from the Delta for irrigation along the west side of the river to replace water lost through diversion of the upper SJR flows.

The principal streams in the basin are the San Joaquin River and its larger tributaries: the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers which all drain the east side of the basin. Major land use along the San Joaquin Valley floor is agricultural, with over 2.1 million irrigated acres, representing 22% of the irrigated acreage in California. Urban growth is rapidly converting historical agricultural lands leading to an increased potential for storm water and urban impacts to local waterways. Timber activities, grazing, abandoned mines, rural communities, and recreation can impact upper watershed areas.

#### 3.2 San Joaquin River Sub-Basins

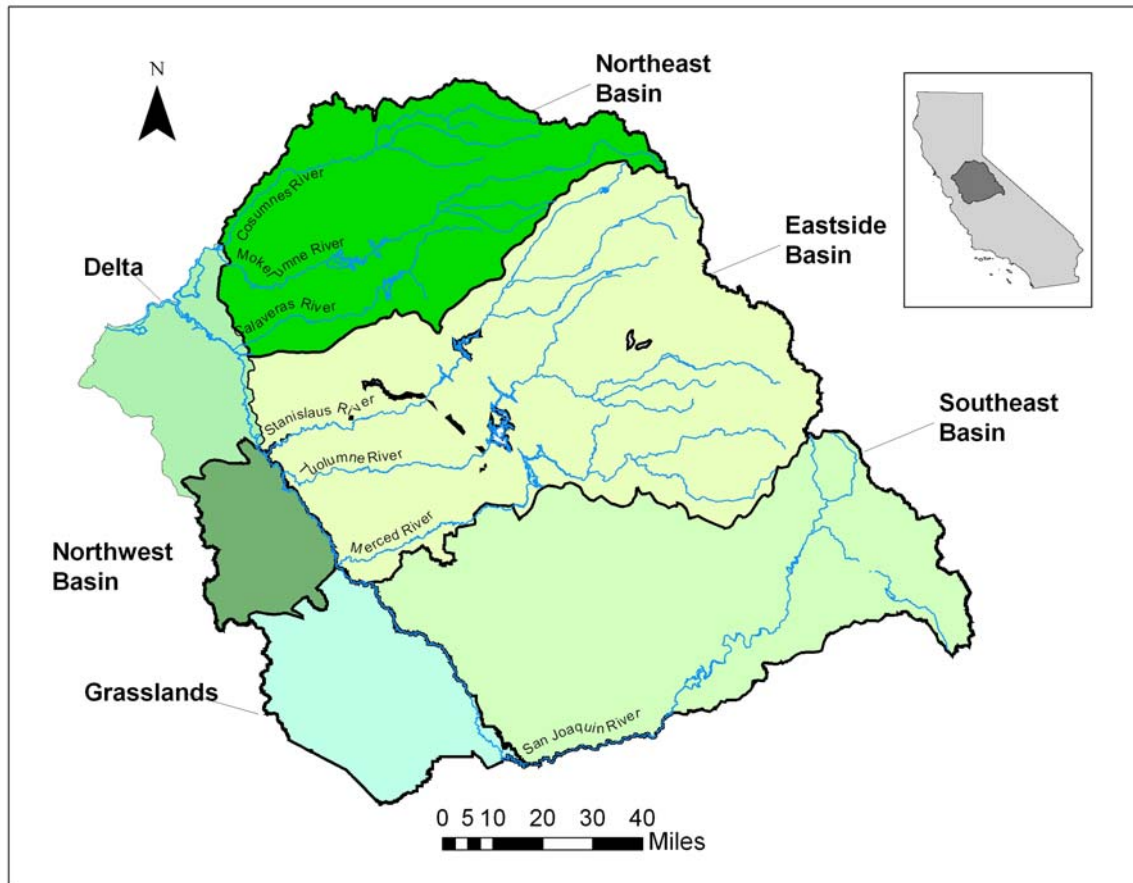
The SJR Basin can be broken into 5 sub-basins of similar hydrology, land use, and management (Figure 1).

1. The **Northeast Basin** consists of the Cosumnes, Mokelumne, and Calaveras River Watersheds, providing a combined drainage of 4,360 square miles.
2. The **Eastside Basin** contains the three largest SJR tributaries, in terms of flow: the Merced, Stanislaus, and Tuolumne River Watersheds, along with the Farmington Drainage Basin and the lower Valley Floor, which drain directly to the SJR. The Eastside Basin is approximately 6,091 square miles.

3. The **South East Basin** is approximately 4,338 square miles and reaches from the headwaters of the SJR north to the watershed divide between Bear Creek and the Merced River in Merced County.
4. The **Northwest Basin** encompasses the watersheds of the creeks draining the eastern slope of the coast range from the Orestimba watershed in the south to the Lone Tree Creek in the north. The basin is approximately 670 square miles, contributing 6 percent of the total SJR flow.
5. The **Grasslands Basin** is a valley floor sub-basin of the San Joaquin River Basin, south of the Orestimba watershed, covering approximately 1,360 square miles. This basin is lies on the Westside of the SJR in portions of Merced, San Benito, and Madera Counties.

This report focuses on the Northeast Basin. More detailed information on these basins can be found at: [www.waterboards.ca.gov/centralvalley/programs/agunit/swamp/index.html](http://www.waterboards.ca.gov/centralvalley/programs/agunit/swamp/index.html) and in a companion report for the Eastside Basin, **San Joaquin River Basin Rotational Sub-basin Monitoring, Phase II: Eastside Basin (Graham, 2007 draft)**

**Figure 1 San Joaquin River Watershed Sub-basins**



### 3.3 Northeast Basin

The **Northeast Basin** consists of the Cosumnes, Mokelumne, and Calaveras River Watersheds, providing a combined drainage of approximately 4360 square miles (CalWater 22), with elevations ranging from 18 – 10,170 feet above sea level. This basin, with both the Cosumnes and Mokelumne watersheds, provided a unique opportunity to compare the effects of major impoundments on river systems. Besides being adjacent watersheds, these watersheds are similar in climate, geology, land use, and land cover. However, the Cosumnes River is the last river in California that does not have a major in-stream impoundment, while the Mokelumne represents a more typical current day watershed with reservoir regulated flows in the upper and lower portion of the watershed.

This basin lies east of the SJR, West of the Crest of the Sierra Nevada, north of the Farmington Drainage Area and Stanislaus River Watershed, and south of the American River Watershed. Counties included in the Northeast basin include Calaveras, Amador, El Dorado, Sacramento, and San Joaquin. Communities within the area include Jackson, Sutter Creek, Lone, and Sheep Ranch. Major reservoirs include Jenkinson Lake, Camanche Reservoir, Pardee Dam, Salt Springs Reservoir, Bear River Reservoir, Amador Lake, and New Hogan Reservoir. The upper watershed areas supported gold mining activities in the mid 1800's. More common now is timber harvest activities, as well as developed areas and recreation. The lower watershed area is dominated by orchards and row crops, as well as urban and rural communities.

The northern most sub watershed is the approximately 1100 square mile<sup>1</sup> Cosumnes River Watershed. Although there are not any major in-stream impoundments, there are several small drinking water reservoirs on tributaries of the Cosumnes. The Cosumnes River supports several uses, including rural and urban communities, contact and non-contact recreation, range cattle, vineyards and other agricultural endeavors.

Aside from the North, Middle, and South Forks of the river itself, the primary inflow to the Cosumnes River is Deer Creek, a natural, intermittent stream which can receive agricultural tail water, and Laguna-Hadleysville Creek, a natural channel which ceases to flow annually from April until the first major storm in the fall. The confluence of Deer Creek and the Cosumnes River is just east of Highway 99, between Grant Line Road and Dillard Road. Deer Creek runs for about 15 miles and flows within the Omochochumne-Hartnell Water District when agricultural tail water is available during the irrigation season (May through September). Tail water return flows begin in the district, but do not flow beyond the Highway 99 Bridge. Laguna Creek receives water from the Folsom-South Canal by the Galt Irrigation District, which also diverts water into Hadselville Creek, a tributary of Laguna Creek. Agricultural supply water dominates the channel from April through September for about 10.8 miles until it drains into a shallow lakebed. This lakebed drains into the Cosumnes River just south of Twin Cities road, between Highways 5 and 99. (ISWP, 1993)

The North Fork of the Cosumnes River originates just above White's Meadow at the southern end of Mormon Emigrant Trail about two miles from its junction with Highway 88. The Middle Fork of the Cosumnes originates at the Middle Fork Cosumnes campground north of Highway 88 on the El Dorado-Amador County line. The South Fork of the Cosumnes River originates 5,000 feet above sea level northeast of Cook's Station along State Highway 88. The river continues down through the foothills, flows into the Mokelumne River near Walnut Grove and enters the San Joaquin River south of the Sacramento-San Joaquin River County line, near Highway 12. The three main forks and final main river channel total approximately 246 river miles. During the summer months, the Cosumnes is normally dry from the Highway 16 Bridge in Rancho Murieta to its confluence with the Mokelumne River near Mokelumne City. Communities along the river include Pleasant Valley, Nashville, Enterprise, Plymouth, Rancho Murieta, and Wilton.

The Sutter Creek Watershed, approximately 200 square miles<sup>2</sup>, lies between the Cosumnes and Mokelumne Watersheds and includes Jackson, Sutter and Dry Creeks. In the maps of the watershed, it is included in the Cosumnes Watershed. However, the integration point with the Mokelumne River is upstream of the confluence with the Cosumnes River, and therefore should be considered part of the Mokelumne Watershed. Sutter Creek drains into Dry Creek west of Lone and north of Camanche Reservoir. Dry Creek makes a sharp turn southward, and then heads west again when Jackson Creek joins it. Dry Creek then flows into the Mokelumne River upstream of its confluence with the Cosumnes River.

The Mokelumne Watershed, draining approximately 1100 square miles<sup>3</sup>, may be impacted from various urban and agricultural sources before flowing into the SJR Delta near New Hope Landing. The North Fork of the Mokelumne originates above Salt Springs Reservoir, which is bordered by El Dorado National Forest and Stanislaus National Forest on State Highway 207. The Middle and South Forks of the Mokelumne River originate just west of Highway 4, near the towns of Ganns and Cabbage Patch. Recreation is common in the upper and middle watershed. At the base of Camanche Dam lies the Mokelumne River Fish Hatchery (MRFH). East Bay Municipal Utilities District (EBMUD) manages the river fisheries and monitors its contribution to the Bay-Delta ecosystem. The Lower Mokelumne River Hydroelectric Project, licensed by the Federal Energy Regulatory Commission (FERC), regulates all activities on land and waterways owned by EBMUD in the Sierra foothills, including the protection of all public trust resources. The three

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<sup>1</sup> Area is based CalWater22 upper Cosumnes and Lower Cosumnes/Dry Creek Watersheds in Figure 2.

<sup>2</sup> Area is based on the CalWater22 Sutter Creek Watershed in Figure 2

<sup>3</sup> Area is based on the CalWater22 Mokelumne Watershed in Figure 2.

forks comprising the upper watershed account for 403 river miles, while the lower Mokelumne River continues 29.6 miles from the base of Camanche Dam through the foothills, the greater Lodi area, and enters the Sacramento-San Joaquin Delta south of the Sacramento-San Joaquin River County line, near Highway 12. Communities along the river include Pine Grove, Jackson, Valley Springs, Sutter Creek, Amador City, Ione, Lockeford, Lodi, and Galt.

The southern most sub watershed is the Calaveras River watershed, (600 square miles<sup>4</sup>). The North Fork of the Calaveras River originates just above Redhawk Lake in Calaveras County, at elevation 2,771 feet. The South Fork originates near the town of Fourth Crossing, on Highway 49. The two forks empty into New Hogan Reservoir shortly after their origin. From there the Calaveras River flows down into the northern San Joaquin Valley, where it is partially diverted into Mormon Slough at Bellota Dam and Mosher Creek at New Hogan Reservoir for agricultural supply water during the irrigation season. The resulting tail water flows into the Old Calaveras Channel to be captured by flash dams for agricultural use. The four major tributaries in the lower watershed are Duck Creek, Indian Creek, South Gulch and Cosgrove Creek. Communities along the river include Sheep Ranch, Mountain Ranch, San Andreas, Jenny Lind, Bellota, Waterloo, and Stockton.

#### **4.0 SAMPLING PROGRAM**

This water quality-monitoring program was conducted in the Northeast Basin between January – December 2002. Sampling locations (Figure 2 and Table 1) were chosen in an effort to provide integrator sites at the lower end of sub watersheds as well as some targeted sites to represent specific land use (e.g. rural urban communities). Main components of the study included evaluating spatial and temporal trends of key constituents and determining whether there was any evidence that beneficial uses were not being protected. Appendix C summarizes for each site the applicable Basin Plan objective, potential and existing beneficial uses, and whether the uses are based the reach being designated in the Basin Plan or if the reach is tributary to a designated reach.

In order to maximize limited resources and facilitate information exchange, other stakeholders involved in monitoring in this area were contacted directly and by survey. These entities include University of California, Davis (UC Davis), East Bay Municipal Utility District (EBMUD), United States Geological Survey (USGS), local water and drainage districts, and various Municipalities and Utility companies. These and other agencies, as well as known stakeholder groups, were contacted during the developmental stage of the program to determine existing and historic sampling locations, available information, and local community concern. All groups and individuals contacted are listed in Appendix E. Information gathered was combined with land use data, hydrologic characteristics and available resources to determine site locations, constituents of concern, and sampling frequency. Since the data generated by the other groups working in this sub basin is not available in one location, the sampling design had to be complete in itself to answer spatial, temporal, and beneficial use questions. In addition, the study design attempted to capture sites that were identified as of particular concern to local stakeholders.

Dependent on the site, constituent of interest, and available funding, monitoring was conducted twice per month, quarterly, or on an annual basis. Information on the monitoring locations, frequency, and constituents sorted by sub watershed is contained in Table 1.

Grab samples were collected twice a month and included field measurements of dissolved oxygen (DO), electrical conductivity (EC), pH, temperature, turbidity, total coliforms, and *Escherichia coli* (*E. coli*). Additional samples were collected less frequently for total suspended solids (TSS), total organic carbon (TOC), nutrients including ammonia nitrogen, Kjeldahl nitrogen, nitrate + nitrite, nitrate, ortho-phosphate, phosphorus, and potassium, water column toxicity

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<sup>4</sup> Area is based on the CalWater22 Calaveras Watershed in Figure 2.

including acute 48 hour water flea (*Ceriodaphnia dubia*) and chronic 96 hour fathead minnow (*Pimephales promelas*), and trace elements (TE) including arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc and associated hardness.

#### 4.1 Sampling Sites

Each site was assigned a site code and a site name. The site code begins with either the first three letters of the county in which the site is located (e.g., CAL represents Calaveras County), or the first letters of each word in the county name, plus 'C' for county (e.g., SJC represents San Joaquin County). The three numbers in the site code are arbitrarily chosen, but unique to each site in that county.

Site locations are depicted in Figure 2, with site codes matching those listed in Table 1.

Two sites included in this sampling effort are also long-term SWAMP sites (Cosumnes River at Twin Cities Road and Mokelumne River at New Hope Road). Long-term monitoring sites are sampled on a monthly basis to provide information for comparison of water quality data during different water year types and help determine which constituents to monitor during rotations into the various drainage basins.

Detailed site descriptions, including photo documentation of each site, is located in Appendix A.

**Table 1 Sampling Site Locations and Constituents Monitored During Northeast Basin Study, January - December 2002**

Site Code	Site Location	Approximate Elevation (feet)	Comments	Flow	EC	pH	Temp	DO	Turbidity	TE (Tot & Dis)	Nutrient A	TSS	TOC	Bacti	Tox-test 96/48 hr Acute
<b>Cosumnes River Watershed</b>															
ELD 001	Jenkinson Lake @ Pincone Campsites 1-38	3470	Surface Area – 650 acres		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	B
ELD 002	Jenkinson Lake Dam @ Mormon Emigrant Trail	3470	Storage Capacity – 41,000 Acre-Feet		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	
ELD 003	Cosumnes R. @ Gold Beach Park	840	~River Mile 55		BM	BM	BM	BM	BM	B	B	BMP	BMP	BM	
ELD 004	Cosumnes R. @ Hwy 49	800	~River Mile 53		BM	BM	BM	BM	BM	B	B	BMP	BMP	BM	B
SAC 003	Cosumnes R. @ Michigan Bar Rd.	168	~River Mile 36	C	BM	BM	BM	BM	BM	B	B	B	B	BM	
SAC 001	Cosumnes R. @ Twin Cities Rd.	30	~River Mile 5 from the Confluence with Mokelumne River Dry Jul - Nov		BM	BM	BM	BM	BM	B	B	A	BMP	BM	
<b>Mokelumne River Watershed</b>															
AMA 001	N. Fork Mokelumne R. @ Hwy 26	2000	~River Mile 92		BM	BM	BM	BM	BM	B	M	BM	BMP	BM	
AMA 002	Sutter Ck. @ Hwy 49	1200	Dry Oct, No Flow Aug - Oct		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	A
CAL 004	Mokelumne R. @ Hwy 49	600	~River Mile 86		BM	BM	BM	BM	BM	B	M	BMP	BMP	BM	B
AMA 003	Lake Amador @ Lake Amador Boat Launch	470	Surface Area – 425 Acres Storage Capacity – 22,000 Acre-Feet		BM	BM	BM	BM	BM	B	MP	BM	BMP	BMP	A
CAL 005	Camanche Reservoir @ the South-shore Recreation Area	235	Drainage to River ~ River Mile 64 Surface Area - 7,770 Storage Capacity – 431,000 Acre-Feet		BM	BM	BM	BM	BM	B	MP	BM	BMP	BMP	A



Site Code	Site Location	Approximate Elevation (feet)	Comments	Flow	EC	pH	Temp	DO	Turbidity	TE (Tot & Dis)	Nutrient A	TSS	TOC	Bacti	Tox-test 96/48 hr Acute
SJC 512	Mokelumne R. @ Van Assen Co. Park	100	~ River Mile 63		BM	BM	BM	BM	BM	B	MP	BM	BMP	BMP	A
SAC 002	Mokelumne R. @ New Hope Rd.	18	~ River Mile 26		BM	BM	BM	BM	BM	B	B	BMP	M	BM	
<b>Calaveras River Watershed</b>															
CAL 001	San Antonio Cr. @ Sheep Ranch Rd.	1975	~16 River Miles upstream of Drainage to S. Fork Calaveras		BM	BM	BM	BM	BM	B	M	BMP	BMP	BM	B
CAL 002	Calaveritas Creek @ Hwy 49	800	<2 River Miles upstream of Drainage to S. Fork Calaveras Dry Aug - Oct		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	
CAL 003	N. Fork Calaveras @ Gold Strike Rd.	800	<2 River Miles upstream of Drainage to N. Fork Calaveras Dry Aug - Nov		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	
CAL 006	New Hogan Res. @ Acorn East Camp ground	600	Drainage to River ~ River Mile 46 Surface Area – 4,400 acres		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	
CAL 007	New Hogan Res. @ Wrinkle Cove	600	Storage Capacity – 325,000 Acre-Feet		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	A
CAL 008	Calaveras R. @ Monte Vista Trailhead	580	~River Mile 45		BM	BM	BM	BM	BM	B	MP	BMP	BMP	BM	A
SJC 513	Calaveras R. @ Hwy 88	60	~River Mile 14.5 Dry Feb, Oct - Dec		BM	BM	BM	BM	BM	B	MP	BM	BMP	BMP	A

A - Annual

BM - 2x/month

M - Monthly

C - Continuous

BMP - 2x/month part of

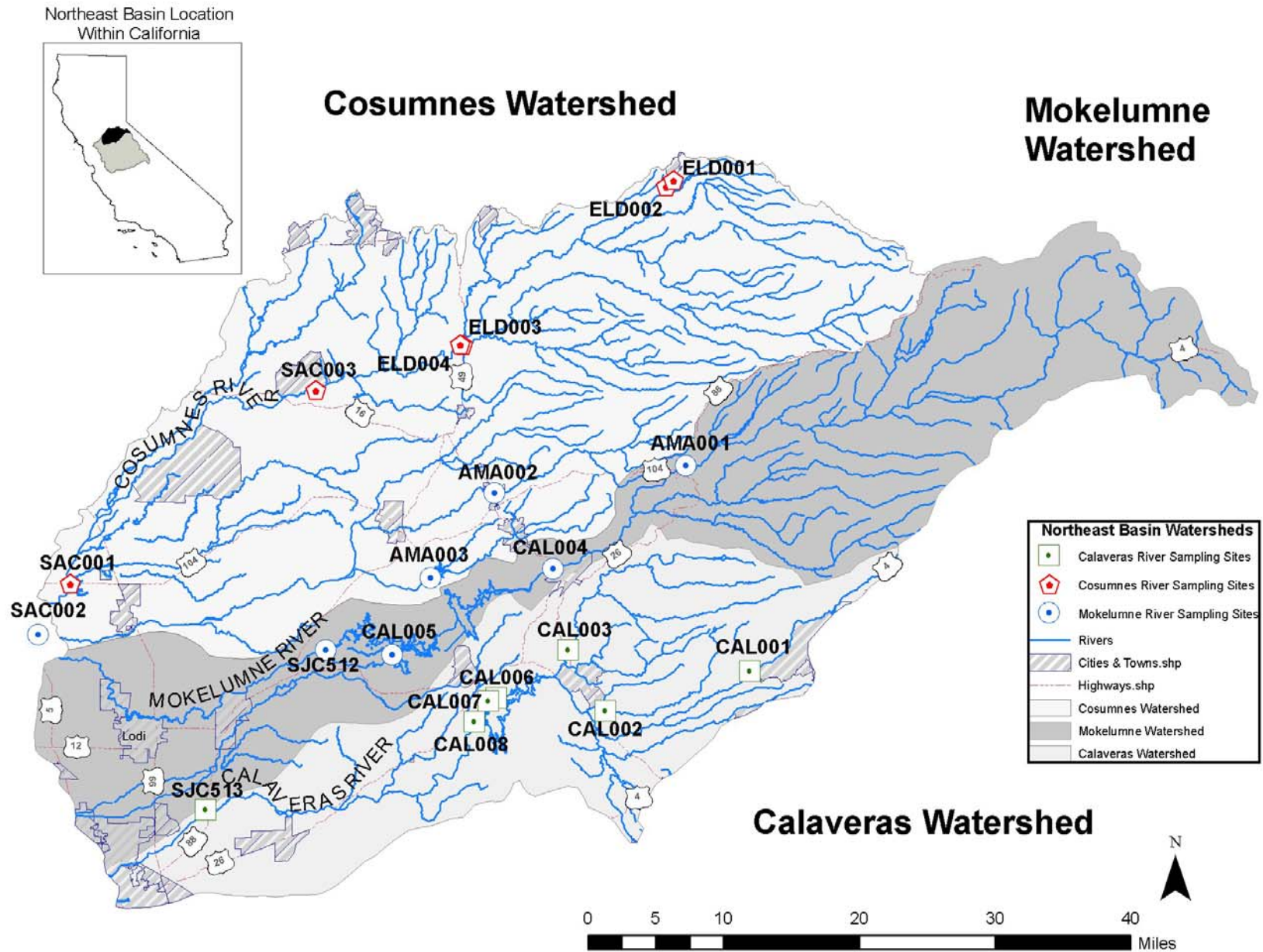
B - 2x/year

the year

MP - Monthly part of the year

River Miles calculated based on Raster Maps

Figure 2 Intensive Basin Monitoring Program - Phase I. Northeast Basin (January - December 2002)



## 4.2 Sample Procedures

Collection and analysis of all water samples occurred in compliance with the Quality Assurance Project Plan (Graham 2001), which was based on the Agricultural Subsurface Drainage Program Procedures Manual (CVRWQCB 1996). The procedures manual was reviewed by the SWAMP QA team after the monitoring in this study was conducted, and found to be compliant. In general, sample bottles were triple rinsed with sample water before the actual sample was collected, except in the cases where sample bottles were preacidified. In such cases, samples were collected either in a stainless steel cup (TOC) or in a sample bottle that was being used to collect other constituents at the same site (Na bottle used to collect Nb samples). All samples were kept at 4°C during transport.

Contracted laboratories included Twining Laboratories in Fresno, Sierra Foothill Laboratories in Jackson, and the University of California (UC) Davis Department of Land, Air and Water Resources (LAWR) Lab in Davis.

Field measurements included temperature, pH, turbidity, dissolved oxygen (DO), and electrical conductivity (EC), and were collected using Yellow Springs Instruments (YSI) Sonde Model 6920 and Logger Model 650 MDS.

Samples collected for total coliform and *E. Coli* were analyzed using the IDEXX® Colilert-18 method (Analytical methods 9223B in STANDARD METHODS, EDITION 20). Results using the Colilert method are reported in terms of Most Probable Number (MPN). Analysis for total coliform and *E. coli* were conducted in the Central Valley Regional Water Quality Control Board laboratory.

TSS samples were submitted to Sierra Foothill Laboratories for analysis, except for June, when samples were sent to Twining Laboratories for analysis.

All Total Organic Carbon (TOC) samples were submitted to Twining Laboratories for analysis.

The following constituents were included in the nutrient series analysis: Ammonia, Total Kjeldahl Nitrogen (TKN), nitrate, nitrite + nitrate, ortho-phosphate, total phosphorus, and potassium. Nutrient samples were submitted to the UC Davis Department of LAWR Laboratory for analysis, except for the month of June, when samples were sent to Twining Laboratories.

During 2002, Sierra Foothill Laboratories analyzed samples for water column toxicity. Two types of toxicity tests were performed in the analyses: 48-hour acute toxicity of water column *Ceriodaphnia dubia* (*C. dubia*) a water flea, and 96-hour acute toxicity of *Pimephales promelas* (*P. promelas*) fathead minnow. All results are reported as the percent survival at the conclusion of the test. Samples were collected for toxicity at selected sites and submitted within 24 hours of collection to Sierra Foothill Laboratories for analysis.

The following constituents were included in the trace element series analysis: total and dissolved chromium, copper, lead, zinc, mercury, cadmium, arsenic and hardness. All samples were submitted to Twining Laboratories for analysis within 48 hours of collection.

Benthic macroinvertebrate (BMI) sampling was conducted in spring and fall 2002 at selected sites. Details of the sample collection and analysis can be found in the report titled "Benthic Macroinvertebrate Bioassessment of San Joaquin River Tributaries: Spring and Fall 2002", which can be found on the internet at the following link:  
[http://www.waterboards.ca.gov/centralvalley/available\\_documents/waterqualitystudies/SJR02\\_Bioassess\\_final\\_083005.pdf](http://www.waterboards.ca.gov/centralvalley/available_documents/waterqualitystudies/SJR02_Bioassess_final_083005.pdf)

#### 4.3 Quality Assurance and Quality Control

Quality assurance (QA) and quality control (QC) logs for constituents analyzed by outside labs are maintained by the Contract Manager. The QA/QC logs for bacteria analysis are maintained in the CVRWQCB laboratory where samples are analyzed.

Transport contamination was evaluated by submitting a travel blank on a monthly basis for most constituents, and on each run for bacteria monitoring. For most constituents, the travel blank consisted of a sample of deionized water that was collected at the CVRWQCB laboratory. For bacteria monitoring, the travel blanks were initially produced by using boiled deionized water and sodium-chloride (NaCl). From June to December, travel blanks were made from Type II water prepared by the Department of Plant Sciences, University of California Davis. Type II water is autoclaved double deionized water. All blanks made with Type II water were negative for contamination. The travel blanks traveled through the sampling run, and were processed with the sample set. With one exception, all results for travel blanks fell below the analytical detection limits for the elements of concern.

The one exception was the bacteria blanks during the week of May 20-22. Travel blanks tested positive for Total Coliform, and negative for *E. coli*. Data from this sampling event is included in this report, with notes of the blank results.

The contract laboratory provided travel blanks for toxicity analysis.

Consistency in sample collection and analysis was maintained by using procedures approved by SWAMP. Analytical methods used in this program are identified in Table 2.

Analytical precision and accuracy were evaluated using blind duplicate and split samples. Blind duplicate or split samples were collected at a 10% frequency for each sampling event. Duplicate samples were collected in two separate containers. Split samples were collected in a container double the normal sample volume and splitting that sample into two equal amounts for submittal to the analyzing laboratory. Toxicity samples were collected as duplicates, but then composited and split at the lab.

Potential contamination from the reagent grade nitric acid used to control pH was evaluated by submitting a deionized water matrix preserved with 1-ml of acid per 500-ml of sample, to the contract laboratories at monthly intervals to be analyzed for the trace elements of concern. All reported recoveries for these acid check samples were below the analytical detection limit.

Only data from sample sets whose blind QA/QC met specifications outlined in **Table 2** have been included in this report. These specifications are consistent with the QAPP for this program (Graham 2001).

**Table 2 Parameters, Detection Levels, Holding Times, and Acceptable Analytical Recoveries**

Constituent	Laboratory	Units	Method	MDL	Recovery	Holding Time	Container	Completeness	Duplicates	Splits
<b>Nutrient scan</b>										
nitrate	Twining	mg/L	SM 300.0	2	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
ammonia	Twining	mg/L	SM 350.3	1	80 - 120%	24 hrs <sup>B</sup>	plastic	95%	X	
total phosphorus	Twining	mg/L	SM 365.3	0	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
total kjeldahl nitrogen	Twining	mg/L	SM 450.0	2	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
ortho phosphate	Twining	mg/L	SM 300.0	1	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
potassium	Twining	mg/L	SM 200.7	1	85 - 115%	24 hrs <sup>C</sup>	plastic	95%	X	
nitrate	UCD	mg/L	SM 300.0	10	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
ammonia	UCD	mg/L	SM 350.3	10	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
total phosphorus	UCD	mg/L	SM 365.3	50	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
total kjeldahl nitrogen	UCD	mg/L	SM 450.0	20	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
ortho phosphate	UCD	mg/L	SM 300.0	50	80 - 120%	24 hrs <sup>C</sup>	plastic	95%	X	
potassium	UCD	mg/L	SM 200.7	5	85 - 115%	24 hrs <sup>C</sup>	plastic	95%	X	
<b>Trace Elements</b>										
Copper	Twining	ug/L	SM 200.7	1.0	80-120%	6 mos <sup>A</sup>	plastic	95%		X
Chromium	Twining	ug/L	SM 200.7	1.0	80-120%	6 mos <sup>A</sup>	plastic	95%		X
Lead	Twining	ug/L	SM 200.7	5.0	70-130%	6 mos <sup>A</sup>	plastic	95%		X
Nickel	Twining	ug/L	SM 200.7	5.0	70-130%	6 mos <sup>A</sup>	plastic	95%		X
Zinc	Twining	ug/L	SM 200.7	2.0	60-140%	6 mos <sup>A</sup>	plastic	95%		X
Arsenic	Twining	ug/L	SM 200.7	4.0	65-135%	6 mos <sup>A</sup>	plastic	95%		X
Cadmium	Twining	ug/L	SM 200.7	0.1	70-130%	6 mos <sup>A</sup>	plastic	95%		X
Mercury	Twining	ug/L	SM 200.7	0.2	70-130%	6 mos <sup>A</sup>	plastic	95%		X
Selenium	Weck	ug/L	ICP-MS hydride	0.4	90-110%	6 mos <sup>A</sup>	Plastic	95%		X
Hardness	Twining	mg/L	SM 200.1	1.0	80 - 120%	7 days <sup>C</sup>	plastic	95%		X
Total Suspended Solids (TSS)	Twining	mg/L	SM209C	10.0	80-120%	7 days <sup>C</sup>	500 ml p	95%	X	
	Sierra Foot Hill	mg/L	SM2540D	1	80 - 120%	7 days <sup>C</sup>	1 L p	95%		X
Total Organic Carbon (TOC)	Twining	mg/L	EPA 415.1	1.0	80- 120%	28 days <sup>B</sup>	amber glass	95%		X
<b>Freshwater Toxicity</b>										
48 hours acute	Sierra Foot Hill	% Survival	EPA600/4-90-027F		Sig. Diff., or 30%	30 Hr <sup>C</sup>	glass	95%	X	
96 hours acute	Sierra Foot Hill	% Survival	EPA600/4-90-027F		Sig. Diff., or 30%	30 Hr <sup>C</sup>	glass	95%	X	
<b>YSI</b>										
pH	CVRWQCB	pH	1/150.1		N/A	on site		95%		
Electrical Conduct.	CVRWQCB	mS/cm	b/120.1		N/A	on site		95%		
Temperature	CVRWQCB	°C	temperature		N/A	on site		95%		
Dissolved Oxygen	CVRWQCB	mg/L	Rapid Pulse		N/A	on site		95%		
Turbidity	CVRWQCB	NTU	SM 2130B/ EPA180.1		N/A	on site		95%		
<b>Colilert 18</b>										
Total coliform	CVRWQCB	MPN	SM9223B	1MPN /100 ml	95% CI	24 Hr <sup>C</sup>	100 ml p	95%	X	
<i>E. Coli</i>	CVRWQCB	MPN	SM9223B	1MPN /100 ml	95% CI	24 Hr <sup>C</sup>	100 ml p	95%	X	
A. When preserved to a pH <2 using nitric acid within 24 hours of sample collection										
B. Cool, 4°C, H <sub>2</sub> SO <sub>4</sub> to pH<2										
C. Cool 4°C										

### *Field Equipment and Analytical Methods*

The CVRWQCB San Joaquin River Watershed Unit practices a standard quality assurance procedure with all its sampling programs that includes calibration of sampling equipment prior, during, and after each sampling run. Calibration procedures can be found in the Ag Procedures Manual (CVRWQCB 1996). Analytical methods utilized are listed in Table 2.

### *Bacteria Analysis*

Results for total coliforms and *E. coli* were recorded as Most Probable Number (MPN) per 100 ml of sample water and were detectable between 1 to 2419.2 MPN. Results above and below the counting limit were recorded as >2419.2 and <1, respectively.

Replicate bacteria samples were initially collected and analyzed at a 10 percent frequency (1-replicate per 10-samples) in an effort to evaluate analytical precision. However, a review of sampling methodologies indicated that replicate bacteria samples provided information on inherent stream variability rather than analytical precision. The IDEXX methodology does not require duplicates or replicates and reports a 95% Confidence Interval for precision. Therefore, all data collected during this study has been reported, and variability in replicate samples noted.

## **5.0 PRECIPITATION AND FLOW: CALENDAR YEAR 2002**

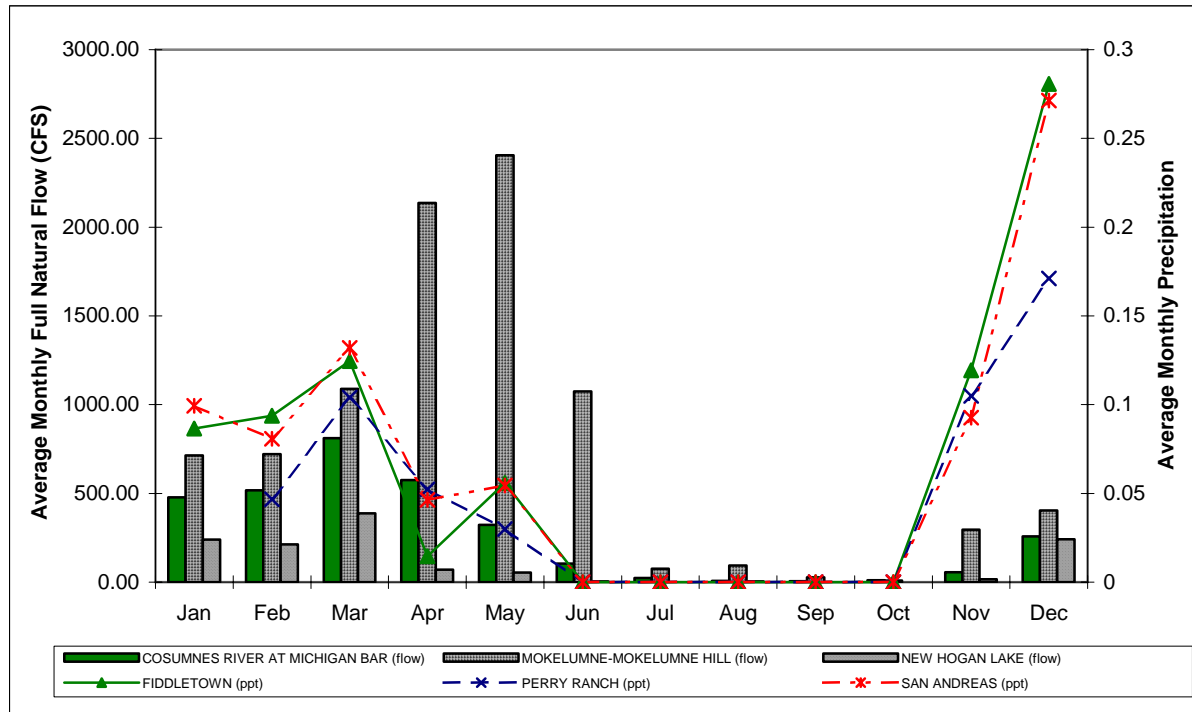
The San Joaquin River Index, as described in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (SWRCB, 1995) is used to classify the water year type in the river basin based on runoff. The 60-20-20 Index includes five classifications; wet, above normal, below normal, dry, and critical, based on millions of acre-feet of calculated unimpaired flow.

A Water Year begins 1 October and ends 31 September of the following year. Because of the timing of this study, January – December 2002, Water Years 2002 and '03 are represented. The San Joaquin River Index classified January – September 2002 “dry” and October – December 2002 “below normal”.

Data from the California Data Exchange Center was used to create Figures 3-6. Flow data was recorded at Cosumnes River at Michigan Bar (MHB), Mokelumne River at Mokelumne Hill (MKM), and Calaveras River at New Hogan Lake (NHG). Incremental precipitation data came from stations at Fiddletown (FDL – Cosumnes Watershed), Perry Ranch (PRY – Mokelumne Watershed), and San Andreas (SDR – Calaveras Watershed).

Figure 3 shows average monthly measured flow compared to average monthly incremental precipitation for each of the major rivers contained within the Northeast Basin. Flows were highest during the spring months, with contributions from both precipitation and snow melt. Precipitation was highest during the fall storm flows, with average precipitation during spring storms was only half the amount of fall storms.

**Figure 3 Average Monthly Flows vs. Precipitation in Cosumnes, Mokelumne, and Calaveras Watersheds (January - December 2002)**

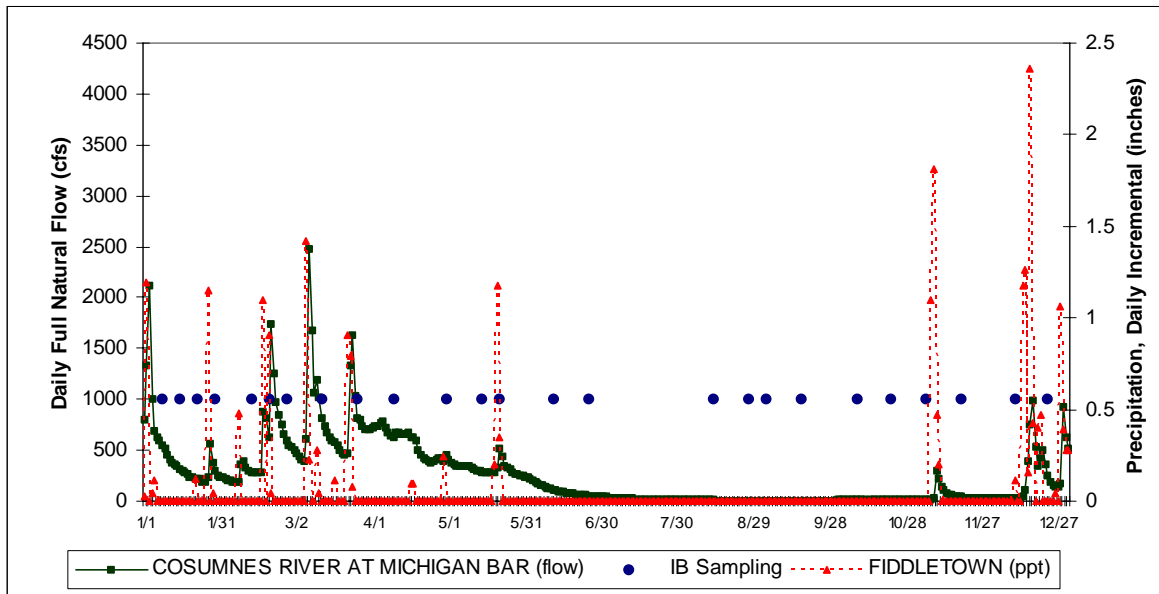


Figures 4 through 6 relate sampling events to flow and precipitation. Precipitation and flow patterns varied depending on the watershed.

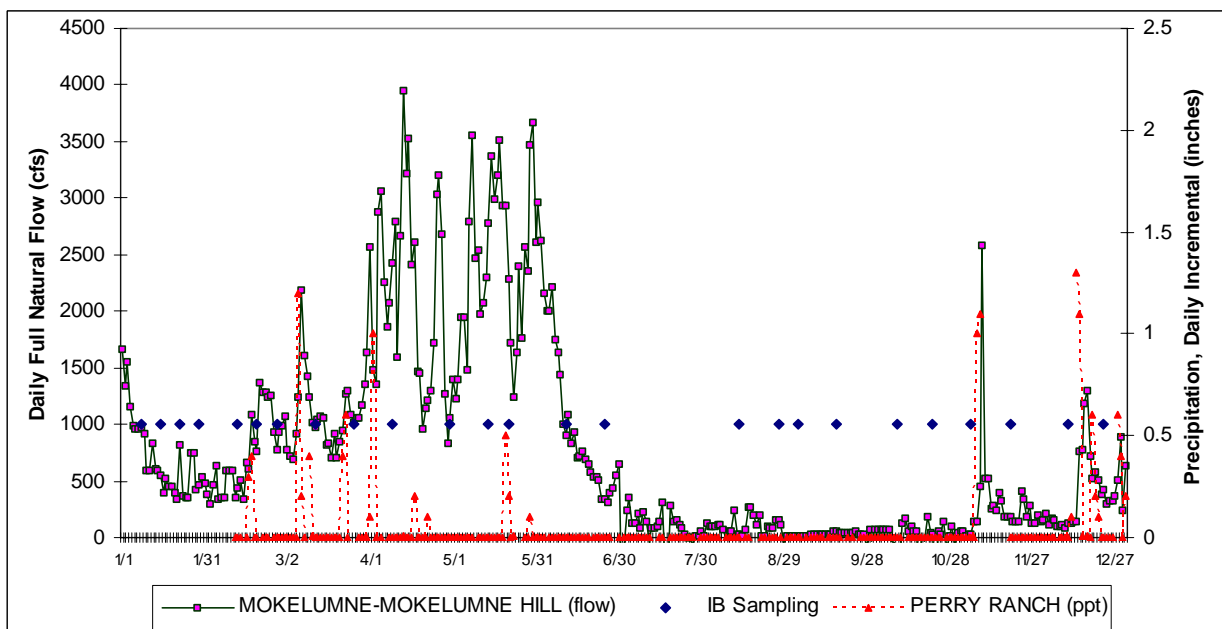
In both the Cosumnes Watershed and Calaveras River watersheds, increased precipitation was closely related to increased flows, with several precipitation events in the early part of the year (January – March), resulting in a period of high flows with peaks coinciding with the precipitation events. During April to May, precipitation events were less frequent, however in the Cosumnes watershed, since snow melt flow was unregulated, flow was more variable than in the Calaveras watershed. During the summer and fall months, June through October, there was no precipitation and flow dropped below 10 cfs in both watersheds. The drop in flow was more gradual in the Cosumnes watershed, which had a monthly mean of 104 cfs in June, while in the Calaveras watershed, the June monthly average was 3 cfs. The storm season started in November, initially causing a peak in flow within both watersheds. In December, more frequent storms lead to a sustained increase in flow.

In the Mokelumne watershed, flow coincides more closely with releases from Electra Dam to comply with a FERC license condition than precipitation. The diversion canal providing these flows begins at Lower Bear Reservoir, then parallels the North Fork Mokelumne and the Mokelumne River, ending at the Electra Powerhouse. There was no precipitation data available from January to early February; it is therefore assumed that the peaks in flow during this period were due to releases from the Dam. From March through June, flows reached a peak of 2400 cfs, with a mean of 2270 cfs, more than five times greater than of the mean flow in the Cosumnes Watershed. During the period with no precipitation, flow ranged from 9 – 1075 cfs. During the storm season in November and December, mean precipitation for the two months was lower than in the Cosumnes and Calaveras Watersheds. However, the mean flow in the Mokelumne Watershed equaled the combined mean flow from the Cosumnes and Calaveras Watersheds.

**Figure 4 Daily Flow vs. Daily Incremental Precipitation, Cosumnes Watershed (January - December 2002)**



**Figure 5 Daily Flow vs. Daily Incremental Precipitation, Mokelumne Watershed (January - December 2002)**





**Figure 6 Daily Flow vs. Daily Incremental Precipitation, Calaveras Watershed (January - December 2002)**

